NASA TT F-9728

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Translation of "Polet kosmicheskogo korablya 'Voskhod-2'"
Paper presented at the XVI International Astronautics Congress, Athens, 13-18 September 1965.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON OCTOBER 1965

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On 18 March 1965, at 1000 hours Moscow time, a powerful carrier rocket /1 placed the piloted spacecraft "Voskhod-2" into Earth orbit from the Soviet Union. The commander of this spacecraft was myself, and Lieutenant Colonel A. A. Leonov was the copilot.

As is known, the spacecraft was placed in an orbit with the following parameters: minimum distance from the Earth's surface (perigee), 175 km; maximum distance (apogee), 495 km; inclination of the orbit from the plane of the equator, about 65°; period of rotation around the Earth, 90.0 min.

The flight of the "Voskhod-2" spacecraft lasted 26 hours, during which time it made 17 orbits around the Earth and travelled a distance of more than 720,000 km.

Landing was accomplished by manual control. The spacecraft landed on 19 March 1965, at 1202 hours Moscow time, in the vicinity of the city of Perm'.

Characteristics of the "Voskhod-2" Spacecraft

The "Voskhod-2" spacecraft is an entirely new type of vehicle by comparison with its sister ships, the "Vostok" and "Voskhod-1" craft. It consists of a cosmonaut cabin and an instrument compartment. The cabin houses the crew in their spacesuits, the life support systems, control systems, indicators and signals, and the equipment for conducting medical and biological, and physical

*Numbers given in the margin indicate the pagination in the original foreign test.

and engineering experiments. An airlock is located on the outside of the /2
spacecraft. The vehicle's parachute system and soft landing system are located in a special housing. The instrument compartment contains the equipment required to place the craft into orbit and for orbital flight, and also the retro-rocket installation.

The crew, wearing abort gear, were seated in their nonejectable chairs, designed for convenience while operating the equipment and comfort while resting. The life support system was maintaining the following conditions inside the vehicle: air temperature, between 15° and 22°C; pressure, 1.0 to 1.1 atm; partial oxygen pressure, not less than 135 mm Hg; percent content of carbon dioxide, not more than 1.5 percent; humidity, between 35 percent and 70 percent. Humidity and temperature could be regulated as we wished.

On the whole, the air regeneration and air conditioning system provided maintenance of the required cabin atmosphere conditions throughout the flight. Thus conditions in the cabin were ordinary, Earthside conditions.

During orbital flight, for convenience in manipulating the equipment, we took off our sealed helmets and gloves.

Spacecraft attitude control for making observations and conducting scientific experiments was accomplished manually. The vehicle could be turned /3
about its center of gravity by means of small thrustors. The vehicle's radio and television equipment provided stable two-way communication with Earth on short and ultra-short wave frequencies, and permitted observation of Leonov's extravehicular activity both from the spacecraft and from the ground.

The vehicle's instrumentation made it possible to monitor the operation of all systems essential to life throughout the flight, from launch to landing.

The airlock, which was designed for extravehicular activity not only on the present flight, but during subsequent orbital flights and on other kinds of space objects, permitted egress without loss of pressure from the main cabin. In addition, the chamber contributed to the safety of egress into space. However, in case of any kind of emergency requiring immediate aid to the copilot outside the vehicle, the capability of immediate depressurization of the cabin without interfering with the operation of any of the equipment was incorporated into the design. Naturally, after rescue and return to the interior of the vehicle, normal conditions could be restored inside the cabin.

The parachute system and soft landing system assured a soft landing in the full sense of the word, without any sensation of striking the Earth. Besides the above mentioned items, the cabin also contained the onboard food ration, consisting of ordinary "terrestrial" products assorted according to our individual tastes.

On board there was also a sanitation facility for accommodating the demands of nature.

It must be said that the reliability of Soviet spaceflight equipment is very high. This high reliability is attained not only by the creation of reliable basic systems, but also by providing them with redundancy. However, /4 on no earlier flight was it ever necessary to switch over to operation with an auxiliary system, i.e., no cases of basic system failure occurred.

The purpose of the flight was to perform the extravehicular experiment in space during orbital flight.

While carrying out this experiment, the characteristics of the functional state of the cosmonaut's organism and his ability to control the position of his body in free fall under conditions of weightlessness were to be checked and determined. Simultaneously, comfort and reliability of the spacesuit and the autonomous life support system while the cosmonaut was working in space outside the vehicle were to be evaluated. In addition, the reliability of ship systems operation was to be checked and the value of the program used for ground training of the crew for the experiment now to be carried out for the first time in space was to be tested; and a series of scientific experiments and studies were to be performed.

The schedule of scientific experiments and studies included medical and biological, and physical and engineering experiments.

Preparation for the Flight

The flight of the "Voskhod-2" spacecraft was preceded by long and careful preparation of the flight crew and a standby crew. This training included both general cosmonaut training and specific crew training for the present flight. I trained for the duties of spacecraft commander, while Leonov trained for /5 those of copilot. This is not to say, however, that we could not have substituted for one another during the flight. Leonov was capable of taking over the duties of command, and I was able to do the work of the copilot.

Much has already been said about general cosmonaut training by our pilot-cosmonaut comrades who flew before us. Therefore I will limit myself to discussion of specific training for this flight.

We began our study of the spacecraft at the design office, long before the flight. As the ship was being designed, we took part in the testing of its systems and of the ship as a whole in complex ground tests. This method of learning the ship, especially our participation in the tests, gave us perfect mastery of its systems and confidence in its complete reliability.

The unusual nature of the extravehicular activity experiment and the impossibility of simulating it fully under Earth conditions necessitated the creation of special training devices and laboratories for familiarization with control of the vehicle and its systems, and for working out the egress procedure. A training ship was built which imitated the operation of systems at all stages of flight. In this ship we rehearsed all details of onboard equipment and vehicle attitude control, including emergency procedures, until they became automatic.

In addition, we also ran through the medical and biological studies scheduled in the flight program on this training ship. This not only reinforced our familiarity with the operation of the scientific equipment under spaceflight conditions, but placed at our disposal a great fund of scientific background material. Preliminary familiarization with individual systems control was accomplished on special functional training devices. After all the elements /6 of the flight assignment had been worked out under ground conditions, we began training for egress from the vehicle and re-entry into it in a barochamber under conditions of high vacuum. On conclusion of this training we rehearsed the egress procedure on a mockup of the vehicle which was flown in the cabin of a laboratory airplane. Egress was rehearsed in steps during the short intervals of weightlessness.

Concurrently with our study of the vehicle and training on training devices, we underwent regular physical training of two kinds: general physical training and specialized physical training. The specialized training consisted of vestibular training, centrifuge training, parachute jumps, and other forms of training to increase the resistance of our bodies to the effects of spaceflight factors. All types of training were performed under the continuous supervision of physicians.

During the final phase of our training the flight task was studied. When the whole program of training had been completed, permission was given to make the flight. It should be noted that the broad scope of the training undergone justified itself, since in space we encountered nothing which had not been anticipated and executed the flight task accurately.

At this point it is probably appropriate to recall the dictum of the great warrior Suvorov: "The harder the drill, the easier the battle." This motto is clearly worth remembering during any preparation for spaceflight experiments, particularly if the experiment is being performed for the first time.

Performance of the Flight Program

The principle task to be performed on the flight, as stated above, was that of egress into space wearing the special suit with its individual life support system. The extravehicular activity experiment was begun /7
immediately after insertion of the ship into orbit. Prior to egress the condition of all ship systems was checked. Cosmonaut Leonov then donned his backpack life support system. Pressure inside the airlock was equalized with the pressure inside the cabin. Then the cabin airlock hatch was opened and A. A. Leonov took up his position inside the lock. After the hatch leading from the cabin into the lock was secured, the air inside the lock was bled away and the hatch leading from the lock into space was opened.

After assuring myself that all life support systems were working normally and that Cosmonaut Leonov's pulse and respiration rates were within normal limits, I gave him permission to leave the ship. While A. A. Leonov was outside the ship in space I observed all his actions by television, and monitored the operation of the individual life support system and the condition of the cosmonaut by means of instruments reflecting the basic parameters of the system and the pulse and respiration rates of the cosmonaut. I had a continuous telephone link with A. A. Leonov over which he advised me of all his activities.

Thus, I had full and uninterrupted control of the activities and condition of the cosmonaut during his stay in space.

If it had been necessary, the ship systems were designed to permit me to go to Leonov's rescue and get him back into the ship. Leonov's movements in the airlock and in free fall in space were accompanied by simultaneous slight turns of the ship. Leonov's contacts with the ship and his movements upon the outer surface were clearly audible inside. Thus, in case of failure of other communications equipment during extravehicular activity, audible contact can still be maintained by knocking.

Before re-entering the ship, A. A. Leonov dismounted the movie camera /8 mounted on the rim of the airlock which had filmed his egress. The cosmonaut's re-entry into the vessel was accomplished in reverse order: he entered the lock, closed the outer hatch, the lock was filled with air, the inner hatch was opened, he entered the cabin, and the airlock was secured. The re-entry process proceeded strictly according to this program.

The remainder of the flight was occupied by a series of scientific observations and investigations. These included investigation of the feasibility of visual orientation and astronavigation, determining the parameters of the orbit with the simplest astronomical instruments, meteorological observations, and study of the structure and characteristics of the atmosphere. During the flight a great number of motion and still pictures were made.

The medical and biological experiments included an investigation of the stability of habits in carrying out programmed operations, a study of the characteristics of perception of the colors of individual objects, an investigation of dynamic operator characteristics during work with a special control system model, and determination of the resolving power of the eyes. These medical and biological experiments were conducted at various flight stages, including immediatly following the extravehicular activity. This permitted the effect of the emotional and physiological stress of extravehicular activity on the psychophysiological state of the cosmonaut to be studied.

Analysis of the data obtained showed that under spaceflight conditions visual resolving power and habitual execution of programmed operations undergo no essential changes. /9

Operational visual effectiveness deteriorates approximately 20 percent to 30 percent, which confirms data obtained on the "Voskhod-1" flight. Visual perception of the brightness of colored objects was slightly dulled. For certain colors (green and purple) this decrease was as great as 50 percent.

Interesting data were obtained in studying the dynamic characteristics of an operator in a model control system. Specifically, the experiments conducted make it possible to state that human dynamic characteristics and operator reaction time do not undergo serious changes during exposure to the factors of a 24-hour spaceflight. During such an exposure, the reaction most affected by spaceflight factors is the reaction to input signals with frequencies greater than o.5 cps.

Special vestibular tests were repeatedly carried out by us during the flight; drawing the outline of certain figures before and after vestibular stimulation (sharp head movements). The above mentioned vestibular stimuli evoked no noticeable changes in the quality of outline drawing either at the beginning or at the end of the flight.

We also carried out a study of pulmonary ventilation during flight and took air samples for subsequent analysis of gas composition. Our pulmonary ventilation during flight was increased two- to threefold.

Besides all the above, we conducted an elementary neurological investigation in flight, which showed that pain and tactile sensitivity, two-dimensional spatial and stereognostic perception, and also the ability to recognize objects by touch, underwent no noticeable changes. The conduct of such investigations, of course, had required special preliminary training on our part. /10

All experiments and investigations scheduled were carried out in full.

Deorbit and Landing

Because of failure of one of the commands required to activate the automatic attitude control and the consequent failure of the system to operate, I was required to accomplish the landing using the manual control cycle, that is, to control the ship's attitude by hand and activate the retrorocket installation at the computed time.

The manual attitude control system worked flawlessly. Manual control of the ship's attitude presents no difficulty. However, piloting an airplane and orienting a spacecraft, of course, are two different things.

Doctors agree that the frequency of cardiac contractions is an index of the emotional and physiological state in man. However, we were so thoroughly trained to conduct a manual landing, that our pulse rates while doing so did not noticeably change; from the 12th to the 17th orbit it varied from 80 to 87 beats/min. We believed in the reliability of our ship and were ready to take control of it.

Having oriented the ship, at the computed time I activated the retrorocket system. After loss of orbital speed in the dense layers of the atmosphere, the parachute was released, and, near the ground, the "soft landing" system was activated, which reduced vertical descent velocity practically to zero at the moment of touch-down. We were thus practically unaware of the instant of landing.

After landing and doing a few calisthenics to loosen up a bit on the ground, we used terrestrial communications to get in touch with the search planes and ground search parties, wo took us and our ship to Baykonur. /11

In concluding my brief report on the flight, I would like to state that the execution of experiment on the airlock method of egress into space opens great possibilities for the further conquest of space. Egress into space from future orbiting stations for crew rotation, outside construction, and other purposes is evidently only feasible if the airlock method is used. Thus, the present experiment represents a step toward the development of the space objects of the future.

In conclusion, I would like, on my own behalf and on behalf of Aleksey Arkhiponovich Leonov, to convey from this rostrum our congratulations to the crew of the "Gemini-5" spacecraft, Gordon Cooper and Charles Conrad, on the successful completion of their flight of several days, and to wish them continued success in the peaceful conquest of space.